Aquatic Macroinvertebrate Rapid Bioassessment of Soda Butte Creek, Park County, MT. July 21, 1994.

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Introduction

Concern for water quality and aquatic resources in Soda Butte Creek has prompted the Montana Department of Health and Environmental Sciences - Water Quality Division (WQD) to continue environmental studies of this stream. In 1994, environmental monitoring included water chemistry, periphyton and aquatic macroinvertebrates at five locations in the Soda Butte Creek drainage.

This report presents and analyzes the macroinvertebrate data. The objectives of this report are to (1) provide a current assessment of biotic condition at five stream sites (2) describe the degree and probable causes of biological impairment at each site and (3) develop a baseline for future monitoring.

Rationale

Aquatic macroinvertebrate communities consist primarily of immature insects, including stoneflies (Plecoptera), caddisflies (Trichoptera), mayflies (Ephemeroptera), true flies (Diptera), beetles (Coleoptera) and others. These organisms are important components of aquatic ecosystems, and are the energy links between primary producers (algae), organic inputs to the stream and fish. Macroinvertebrates are good indicators of environmental conditions due to their limited mobility, predictable associations with specific habitats, and differential tolerances to pollution. Evaluating the biological integrity of this assemblage can provide an assessment of environmental quality and can be used to identify limiting factors, for detecting impacts from physical alterations, sediment deposition, nutrients and toxicants, and to document successful mitigation of environmental degradation.

Macroinvertebrate-based Rapid Bioassessment Protocols (RBP) surveys provide a general analysis of biological integrity. This multiple-metric approach quantifies attributes of community composition, structural and functional organization into a single number estimate of biological health. Biological integrity is defined as "the capability of supporting and maintaining a balanced, integrated, adaptive community having species composition, diversity and functional organization comparable to that of natural habitat of the region" (Karr and Dudley 1981).

Study Area

Aquatic macroinvertebrates were collected at four locations on Soda Butte Creek and at one location on Republic Creek in Park County, Montana. Station designations are:

- SB-1 Soda Butte Creek above Cook City
- SB-2 Soda Butte Creek below Cook City
- SB-3 Soda Butte Creek above Silver Gate
- SB-4 Soda Butte Creek below Silver Gate
- Re-1 Republic Creek at confluence with Soda Butte Creek

Republic Creek flows into Soda Butte Creek just below station SB-2.

Methods

Field work was conducted by WQD personnel on 21 July, 1994. At each site, a single collection of macroinvertebrates was obtained using standard traveling kick-net methods (Bukantis 1994). Sampling was conducted after runoff at flows ranging from approximately 10 cfs at the upper site to approximately 20 cfs at the downstream site. Riparian vegetation was generally lacking in the study area.

Laboratory and data analyses were contracted to McGuire Consulting. Techniques described in the most recent Montana RBP guidelines (Bukantis 1994) were followed. RBP III sorting methodology (Plafkin et al. 1989) was employed to obtain a 300 organism subsample from each kick-net collection. Macroinvertebrates were identified to the lowest practical taxonomic level, usually genus or species. Tolerance values and functional designations (Appendix A) used in metric calculations were those recommended by Bukantis (1994).

Macroinvertebrate data were analyzed to provide a numerical estimate of biological integrity. For RBP analyses, Montana streams have been grouped into three primary physiographic regions: mountains, foothills and valleys, and plains (Bahls et al. 1992). Metrics and scoring criteria have been developed for each ecoregion (McGuire 1994). The Soda Butte Creek samples were evaluated using the mountain ecoregion criteria which incorporates seven metrics (Table 1). Each metric received a score ranging from 0 (severely impaired) to 6 (nonimpaired). Scores for all metrics were totaled and biological integrity was expressed as a percentage of the maximum possible score. Impairment classifications (Table 2) were from Plafkin et al. (1989).

A variety of other metrics were also calculated (Appendix B), including a metals tolerance index (McGuire 1993). While not incorporated into the RBP assessment, these metrics were used to further describe the community and supplement baseline data.

Table 1. Metrics and scoring criteria for 300 organism RBP kick samples from mountain streams in Montana.

Mountain	Scoring Criteria			
metric	6	4	2	0
Taxa richness	>28	28-24	24-19	<19
EPT richness	>19	19-18	17-16	<16
Biotic index	<3	3 - 4	4 - 5	>5
% dominant taxon	<25	25-35	35-45	>45
% Collector-FFG	<60	60-70	70-80	>80
% Scrapers+Shredders	>55	55-40	40-25	<25
% EPT	>70	70-55	55-40	<40

Table 2. Criteria for the assessment of biologically significant environmental degradation (from Plafkin et al 1989).

% comp. to reference	Classification
>83%	nonimpaired
54-79%	slightly impaired
21-50%	moderately impaired
<17%	severely impaired

Results and Discussion

Based on mountain ecoregion criteria, RBP assessments indicated slight biological impairment at all five sites (Table 3). Biointegrity estimates for Soda Butte Creek ranged from 81% above Cook City (SB-1) to 57% below Cook City (SB-2). Biological integrity improved gradually downstream from Cook City. Biointegrity was 62 and 67%, respectively, above (SB-3) and below (SB-4) Silver Gate. Biointegrity in Republic Creek, which flows into Soda Butte Creek below SB-2, was 57%.

Symptoms of biological impairment were consistent throughout the study area. At each site, biointegrity was limited by the simplicity of the community and impairment was indicated by structural metrics: taxa richness, EPT richness and the percent relative abundance of the dominant taxa. In contrast, metrics quantifying community composition and functional organization generally received maximum scores.

Habitat degradation and low productivity appeared to be primary causes of biological impairment. During July 1994, the truncated structure and low diversity of the macroinvertebrate community may have been due to armored substrates, low substrate heterogeneity and limited food resources. The low relative abundance of macroinvertebrates that feed on plant debris (shredders) indicated minimal organic input from riparian zones.

The species inhabiting Soda Butte Creek were indicative of excellent water quality and metrics based on indicator-organisms received maximum scores. The metals tolerance index and the biotic index (sensitive to organic pollution) were both extremely low (Appendix B). Benthic community composition appeared typical of a soft-water mountain stream with low productivity. Heptageniid mayflies were numerically dominant at each station.

Among all sites, SB-1 had the highest biointegrity. The benthic community was more diverse and taxa richness was substantially higher at this site than at other sites in the drainage. SB-1 was located immediately below reclaimed mine tailings. It is possible that iron bacteria growing in the stream augmented macro-invertebrate food sources at this site. Both the metals tolerance index and the biotic index were substantially higher at SB-1 than at downstream sites; however, neither metric indicated significant pollution or water quality degradation.

Since Soda Butte Creek has a history of metals pollution, the results of this investigation are somewhat surprising. The macro-invertebrate taxa in the study area were considered highly sensitive to metals pollution and the weight of evidence suggested that metals pollution was not a serious problem during 1994. However, a few metrics could be interpreted as indicating slight metals-related impacts. Low EPT richness is often considered an indicator of metals pollution (McGuire 1993). EPT richness was depressed in both Soda Butte and Republic creeks. In addition, low macroinvertebrate densities can also be indicative of metals pollution and the semi-quantitative (timed) kick samples collected during this study indicated low community density at SB-2 compared to the other sites. Thus, additional macroinvertebrate and water quality investigations may be warranted.

Table 3. Metric values and bioassessments for Soda Butte and Republic creeks, Park County, MT. July 21, 1994.

	stream				
metric	Republic	Soda Butte 1	Soda Butte 2	Soda Butte 3	Soda Butte 4
Taxa richness	18	31	15	15	20
EPT richness	13	16	10	14	17
Biotic index	0.6	2.0	0.3	0.6	0.5
% dominant taxon	47	30	61	42	49
% Collector-FFG	19	40	8	24	17
% Scrapers + Shredders	71	46	80	74	78
% EPT	96	78	94	99	93
			metric score		
Taxa richness	0	6	0	0	2
EPT richness	0	2	0	0	2
Biotic index	6	6	6	6	6
% dominant taxon	0	4	0	2	0
% Collector-FFG	6	6	6	6	6
% Scrapers + Shredders	6	4	6	6	6
% EPT	6	6	6	6	6
total score	24	34	24	26	28
% of reference	57%	81%	57%	62%	67%
classification *	SLI	SLI	SLI	SLI	SLI

* classifications: (NON) nonimpaired, (SLI) slightly impaired, (MOD) moderately impaired,

LITERATURE CITED

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Appendix A. Checklist of aquatic macroinvertebrates from Soda Butte Creek, Park County, MT. 21 July 94 with tolerance values for the biotic index, metals tolerance index and functional feeding group designations.

Taxon	BI	MTI	FFG
COLEOPTERA			
Dytiscidae			
Deronectes sp.	5	7	predator
DIPTERA			
Chironomidae			
Diamesa sp.	5	9	Col-gatherer
Pagastia sp.	1	9	Col-gatherer
Cricotopus sp.	7	9	Col-gatherer
Orthocladius sp.	6	5	Col-gatherer
Paraphaenocladius sp.	4	4	Col-gatherer
Rheocricotopus sp.	4	5	Col-gatherer
Tvetenia sp.	5	4	Col-gatherer
Micropsectra sp.	4	1	Col-gatherer
Tanytarsus sp.	6	3	Filterer
Tipulidae			
Hexatoma sp.	2	2	predator
Rhabdomastix sp.	1	1	Col-gatherer
Ceratopogoninae	6	5	predator
Simuliidae			
Prosimulium sp.	4	2	Filterer
EPHEMEROPTERA			
Baetidae			
Baetis bicaudatus	2	4	Col-gatherer
Ephemerellidae			
Drunella coloradensis	0	0	Scraper
Drunella doddsi	1	0	Scraper
Serratella sp.	2	1	Col-gatherer
Heptageniidae			
Cinygmula sp.	0	0	Scraper
Epeoris deceptivus	0	0	Scraper
Epeorus longimanus	1	0	Scraper
Rhithrogena sp.	0	2	Scraper
Siphlonuridae			
Ameletus sp.	0	1	Col-gatherer

Appendix A. Checklist of aquatic macroinvertebrates from Soda Butte Creek, Park County, MT. 21 July 94 with tolerance values for the biotic index, metals tolerance index and functional feeding group designations.

Taxon	BI	MTI	FFG
PLECOPTERA			
Nemouridae			
Visoka cataractae	0	0	Shredder
Zapada oregonensis gp	3	3	Shredder
Perlodidae			
Isoperla sp.	2	3	predator
Kogotus sp.	1	2	predator
Megarcys sp.	1	1	predator
Chloroperlinae	2	1	predator
Perlidae			
Doroneuria sp.	0	2	predator
TRICHOPTERA			
Hydropsychidae			
Parapsyche sp.	0	1	Filterer
Limnephilidae			
Ecclisomyia sp.	4	2	Col-gatherer
Oligophlebodes sp.	3	1	Scraper
Glossosomatidae			
Glossosoma sp.	0	2	Scraper
Rhyacophilidae			
Rhyacophila alberta gp.	0	1	predator
Rhyacophila brunnea gp.	2	1	predator
Rhyacophila hyalinata gp.	0	1	predator
Rhyacophila verrula gp.	0	1	predator
Rhyacophila vofixa gp.	0	1	predator
ANNELIDA			
Enchytraeidae	4	1	Col-gatherer
Turbellaria	4	4	predator

AQUATIC MACROINVERTEBRATE DATA

Soda Butte & Republic creeks, RBP kick samples 21 Jul 94

Stream:	Republic	Soda Butte				MEAN	Ave.	Relative
Taxon	at mouth	1	2*	3	4		Dev.	%Diff
COLEOPTERA								
Deronectes sp.	0	1	0	0	0	0.2	0.3	160%
DIPTERA								
Diamesa sp.	0	3	0	0	0	0.6	1.0	160%
Pagastia sp.	0	2	0	0	0	0.4	0.6	160%
Cricotopus sp.	1	21	0	0	0	4.4	6.6	151%
Orthocladius sp.	0	2	0	0	0	0.4	0.6	160%
Paraphaenocladius sp.	0	1	0	0	0	0.2	0.3	160%
Rheocricotopus sp.	1	5	1	0	0	1.4	1.4	103%
Tvetenia sp.	3	1	1	0	0	1.0	0.8	80%
Micropsectra sp.	5	2	5	2	18	6.4	4.6	73%
Tanytarsus sp.	0	14	0	0	0	2.8	4.5	160%
Hexatoma sp.	0	0	0	0	1	0.2	0.3	160%
Rhabdomastix sp.	0	1	1	0	0	0.4	0.5	120%
Ceratopogoninae	0	3	0	0	0	0.6	1.0	160%
Prosimulium sp.	0	1	0	0	0	0.2	0.3	160%
EPHEMEROPTERA								
Baetis bicaudatus	38	47	6	71	27	37.8	17.0	45%
Drunella coloradensis	9	8	5	66	17	21.0	18.0	86%
Drunella doddsi	0	0	0	5	2	1.4	1.7	120%
Serratella sp.	0	0	0	0	1	0.2	0.3	160%
Cinygmula sp.	128	85	134	128	145	124.0	15.6	13%
Epeoris deceptivus	36	2	36	19	54	29.4	15.1	51%
Epeorus longimanus	0	0	0	1	0	0.2	0.3	160%
Rhithrogena sp.	13	0	0	2	4	3.8	3.8	99%
Ameletus sp.	0	5	1	0	0	1.2	1.5	127%
PLECOPTERA								
Visoka cat.	0	3	0	0	0	0.6	1.0	160%
Zapada oregonensis gp	5	33	0	1	5	8.8	9.7	110%
Isoperla sp.	2	1	0	0	0	0.6	0.7	120%
Kogotus sp.	0	1	0	0	1	0.4	0.5	120%
Megarcys sp.	5	0	1	1	1	1.6	1.4	85%
Chloroperlinae	0	7	2	0	0	1.8	2.2	120%
Doroneuria sp.	0	1	0	0	0	0.2	0.3	160%
TRICHOPTERA								
Parapsyche sp.	5	6	3	0	3	3.4	1.7	49%
Arctopsyche sp.	0	1	0	0	0	0.2	0.3	160%
Oligophlebodes sp.	2	0	0	2	2	1.2	1.0	80%
Glossosoma sp.	0	0	0	2	1	0.6	0.7	120%
Rhyacophila alberta gp.	3	6	1	0	3	2.6	1.7	65%
Rhyacophila brunnea gp.	0	0	0	1	0	0.2	0.3	160%

AQUATIC MACROINVERTEBRATE DATA

Soda Butte & Republic creeks, RBP kick samples 21 Jul 94

Stream:	Republic	Soda Butte				MEAN	Ave.	Relative
Taxon	at mouth	1	2*	3	4		Dev.	%Diff
Rhyacophila hyalinata gp.	14	2	0	1	1	3.6	4.2	116%
Rhyacophila verrula gp.	0	0	0	0	1	0.2	0.3	160%
Rhyacophila vofixa gp.	2	15	17	3	5	8.4	6.1	72%
ANNELIDA								
Enchytraeidae	0	1	0	0	0	0.2	0.3	160%
OTHERS								
Turbellaria	1	5	5	0	1	2.4	2.1	87%
METRICS								
TOTAL ORGANISMS	273	286	219	305	293	275	23.4	8%
TAXA RICHNESS	18	31	15	15	20	19.8	4.6	23%
EPT RICHNESS	13	16	10	14	17	14.0	2.0	14%
% EPT	96	78	94	99	93	92	6	6%
BIOTIC INDEX	0.57	1.98	0.31	0.55	0.54	0.8	0.5	60%
% DOMINANT TAXON	47	30	61	42	49	46	8.0	17%
% CHIRONOMIDAE	4	18	3	1	6	6	4.6	73%
% Baetidae-EPHEMEROPTER	17	32	3	24	11	17	8.5	49%
% COLLECTORS (g+f)	19	40	8	24	17	22	8.1	38%
% SCRAPER+SHREDDER	71	46	80	74	78	70	9.6	14%
SHANNON DIVERSITY	2.70	3.58	2.02	2.23	2.50	3	0.4	16%
METALS TOLERANCE INDEX	0.97	2.47	0.38	1.00	0.60	1	0.6	51%
EPT/(EPT + Chironomidae)	0.96	0.81	0.97	0.99	0.94	1	0.0	5%
% FILTERERS	2	7	1	0	1	2	2.0	87%
% COLLECTOR-GATHERERS	18	32	7	24	16	19	7.0	37%
% SHREDDERS	2	13	0	0	2	3	3.7	113%
% SCRAPERS	69	33	80	74	77	67	13.3	20%
% PREDATORS	10	15	12	2	5	9	4.2	49%
Scraper/(Scraper+Filterer)	0.97	0.82	0.98	1.00	0.99	0.95	0.05	6%
% COLEOPTERA	0	0	0	0	0	0	0.1	160%
% DIPTERA	4	20	4	1	6	7	5.1	75%
% EPHEMEROPTERA	82	51	83	96	85	80	11.2	14%
% PLECOPTERA	4	16	1	1	2	5	4.4	89%
% TRICHOPTERA	10	10	10	3	5	8	2.7	36%
% MISC	0	2	2	0	0	1	0.9	92%
# of scraper taxa	5	3	3	8	7	5	1.8	35%
# of shredder taxa	1	2	0	1	1	1	0.4	40%
# of predator taxa	6	10	5	4	8	7	1.9	29%
# of C-gatherer taxa	5	13	6	2	3	6	3.0	51%

* entire sample used

AQUATIC MACROINVERTEBRATE DATA RBP KICK SAMPLES
Soda Butte & Republic creeks, RBP kick samples 21 Jul 94

% Relative abundance

	Republic	SB1	SB2	SB3	SB4
COLEOPTERA					
Deronectes sp.	0%	0%	0%	0%	0%
DIPTERA					
Diamesa sp.	0%	1%	0%	0%	0%
Pagastia sp.	0%	1%	0%	0%	0%
Cricotopus sp.	0%	7%	0%	0%	0%
Orthocladius sp.	0%	1%	0%	0%	0%
Paraphaenocladius sp.	0%	0%	0%	0%	0%
Rheocricotopus sp.	0%	2%	0%	0%	0%
Tvetenia sp.	1%	0%	0%	0%	0%
Micropsectra sp.	2%	1%	2%	1%	6%
Tanytarsus sp.	0%	5%	0%	0%	0%
Hexatoma sp.	0%	0%	0%	0%	0%
Rhabdomastix sp.	0%	0%	0%	0%	0%
Ceratopogoninae	0%	1%	0%	0%	0%
Prosimulium sp.	0%	0%	0%	0%	0%
EPHEMEROPTERA					
Baetis bicaudatus	14%	16%	3%	23%	9%
Drunella coloradensis	3%	3%	2%	22%	6%
Drunella doddsi	0%	0%	0%	2%	1%
Serratella sp.	0%	0%	0%	0%	0%
Cinygmula sp.	47%	30%	61%	42%	49%
Epeoris deceptivus	13%	1%	16%	6%	18%
Epeorus longimanus	0%	0%	0%	0%	0%
Rhithrogena sp.	5%	0%	0%	1%	1%
Ameletus sp.	0%	2%	0%	0%	0%
PLECOPTERA					
Visoka cat.	0%	1%	0%	0%	0%
Zapada oregonensis gp	2%	12%	0%	0%	2%
Isoperla sp.	1%	0%	0%	0%	0%
Kogotus sp.	0%	0%	0%	0%	0%
Megarcys sp.	2%	0%	0%	0%	0%
Chloroperlinae	0%	2%	1%	0%	0%
Doroneuria sp.	0%	0%	0%	0%	0%
TRICHOPTERA					
Parapsyche sp.	2%	2%	1%	0%	1%
Arctopsyche sp.	0%	0%	0%	0%	0%
Dolophilodes sp.	1%	0%	0%	1%	1%
Glossosoma sp.	0%	0%	0%	1%	0%
Rhyacophila alberta gp.	1%	2%	0%	0%	1%
Rhyacophila brunnea gp	0%	0%	0%	0%	0%

AQUATIC MACROINVERTEBRATE DATA RBP KICK SAMPLES
Canada Butte & Republic creeks, RBP kick samples 21 Jul 94

% Relative abundance

	Republic	SB1	SB2	SB3	SB4
Rhyacophila hyalinata g	5%	1%	0%	0%	0%
Rhyacophila verrula gp.	0%	0%	0%	0%	0%
Rhyacophila vofixa gp.	1%	5%	8%	1%	2%
Enchytraeidae	0%	0%	0%	0%	0%
OTHERS					
Turbellaria	0%	2%	2%	0%	0%

stations	QSI-taxa	DIC-5	QSI-FFG
1 vs 2	56%	2	65%
1 vs 3	71%	3	87%
1 vs 4	69%	3	77%
1 vs 5	82%	3	94%
2 vs 3	47%	3	53%
2 vs 4	52%	2	66%
2 vs 5	50%	2	60%
3 vs 4	55%	4	65%
3 vs 5	77%	4	87%
4 vs 5	68%	4	77%
min	47%	2	53%
max	82%	4	94%
mean	63%	3	73%